

Lead (Pb) Level of Fresh and Smoked Mackerel Tuna (*Euthynnus affinis*) in Tuban, Indonesia

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Lead (Pb) Level of Fresh and Smoked Mackerel Tuna (*Euthynnus affinis*) in Tuban, Indonesia

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Abstract. Lead (Pb) is a toxic metal compound that can contaminate fish and pose health risks to humans. The purpose of this study was to analyze the level of Pb from fresh and smoked mackerel tuna (*Euthynnus affinis*) sold in Tuban, Indonesia. Mackerel samples were obtained from fish sellers along the highway of Karangsari village, Tuban district, Tuban, Indonesia. The determination of Pb content in mackerel body was carried out through the Atomic Absorption Spectrophotometry (AAS) characterization following with the guidelines of SNI (Indonesian National Standard) year 2011. The research data showed that the range of Pb levels on both fresh fish (0.33 - 14.41 mg/kg) and smoked fish (1.30 - 22.20 mg/kg) exceeds the threshold set by SNI No. 7387 the year 2009. The results of the Mann-Whitney test indicated that Pb level in smoked fish (Mdn = 19.05) was not significantly greater than fresh fish (Mdn = 12.13), $U = 50.00$, $p = 0.219$. Pb levels of mackerel tuna that were above the permissible levels indicate a health risk if the fish is consumed by humans. Monitoring and decision making by the Indonesian government needs to be conducted to overcome Pb contamination that occurs in the sea of Tuban.

Keywords: Mackerel tuna, lead, pollution, aquatic environment, food contamination

1. Introduction

At present, pollution is one of the main problems facing humans [1–3]. Various pollutants have contaminated various ecosystems and caused a decline in the ecosystem quality [4]. One of the pollutants that are considered the most dangerous is lead (Pb) [5–7]. Excessive presence of Pb has a negative impact on various biota [8] and induce various health problems in humans [5, 9]. Besides, exposure to Pb was also reported to reduce hemoglobin levels [10] until disturbing the development of human neurology and intellectuals [11].

Responding to the dangers of Pb, many researchers have conducted the study that examines the presence of Pb contamination in various countries from various continents, such as in Asia [12, 13], Africa [14, 15], as well as Europe [16]. Of the many studies, the presence of Pb in the ocean is one of the research topics that is often studied by researchers. Some studies report that Pb levels were still below the normal limit [15, 17]. However, several other reports report the opposite condition [13], [16].

The presence of Pb in the ocean can be absorbed and accumulated in various marine biota. Some of these biotas are aquatic plants [18], gastropods [19], shellfish [20], and crustacean [21]. Besides some of these organisms, Pb accumulation can also occur in various fish, such as catfish [22], various tuna



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species [23–25] and others [26]. The presence of heavy metal exceeding the limit in fish can cause health problems if humans consume the fish [27, 28]. Therefore, the level of Pb that exceeds the threshold in an ocean is a real threat to human health, both directly and indirectly.

Indonesia is one of the countries that have the longest coastline in the world [29–31]. Many fish from various locations are caught for human consumption [32]. One of the fishes producing regions in Indonesia is in the northern coast of Tuban Regency (Pulau Jawa, Indonesia). A researcher reports that the sea in Tuban is safe from Pb contamination [17]. However, some researchers report that Pb levels in that location exceed the normal threshold [33]. In addition, other reports reveal that also reported the condition of the waters in the North Coast of Java was polluted by Pb [34]. Therefore, further studies to ensure the presence of Pb contamination on the North Coast of Tuban needs to be carried out.

The mackerel tuna (*Euthynnus affinis*) is one of the fishes caught from Tuban that are traded. The assessment of the presence of Pb contaminants in mackerel tuna from Tuban can be used as a parameter of seawater quality in the area. The study also provides information regarding the safety of consumption of fish in Indonesia. Analysis of Pb levels in this study was conducted on not only fresh fish, but also smoked fish. Some previous reports have varied findings regarding the effect of the smoking process on the Pb level in fish [35, 36]. Thus, these conditions also need to be examined in this study. The reason was many fish sellers serve smoked mackerel tuna in Tuban.

2. Methods

2.1. Samples collection

Mackerel tuna was obtained from eight fish sellers located along Jalan Raya Karangasari village, Tuban District, Tuban, Indonesia. The sampling location is a location close to the north coast of Tuban. The mackerel tuna was taken from 4 fish sellers who sold fresh fish and 4 fish sellers who sold smoked fish. Three mackerel tuna were taken from each fish seller, so the total sample used in this study was 24 samples. Sampling collection was conducted in February 2018.

2.2. Lead analysis

Lead content analysis was carried out using the Atomic Absorption Spectrophotometry test according to the guidelines of the Indonesian National Standard (SNI) year 2011. Samples that have been mashed and homogenized were then weighed as much as 1 gram. Next, the fish sample was put into a sample tube and added with 0.2 mL of standard Pb solution. After processed into cortex, 8 mL of 65% HNO₃ and 2 mL of 30% H₂O₂ were added sequentially. Destruction was carried out using a microwave. The results of the destruction were transferred to a 100 mL flask, then a matrix modifier solution and deionized water were added to the solution until the volume of the solution reaching the 100 mL. Furthermore, the sample was read using atomic absorption spectrophotometry (AAS) at a wavelength of 283.3 nm.

2.3. Data analysis techniques

Pb content data obtained were analysed using Independent Samples t-Test. Before performing the t-test, the normality test using Shapiro-Wilk was carried out on the data. If the data did not meet the assumption of normality, data analysis was performed using the Mann-Whitney U test. The significance level used in this study was 5%. Data analysis was using IBM SPSS Statistics 24 software.

3. Results and Discussion

In this study, Pb levels from fresh mackerel tuna and smoked mackerel tuna from the northern coast of Tuban were analysed. The calculation results of Pb levels from each fish sellers are presented in Figure 1. Based on Figure 1, the Pb concentration from one seller to another seller was different. This

difference can be caused by the location where the seller trades. Possible causes of this condition are explained further in other parts of this article.

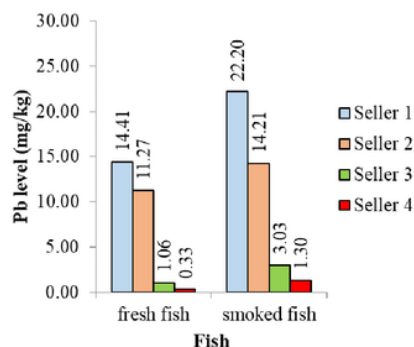


Figure 1. Graph of average Pb level for mackerel tuna fish obtained from eight fish sellers in Tuban

According to SNI No. 7387 the year 2009 about the maximum limit of heavy metal contamination in fish and processed fish, the maximum limit of lead for fish is 0.30 mg/kg. According to data presented in Figure 1, the range of Pb on fresh fish was from 0.33 to 14.41 mg/kg, while the smoked fish was 1.30 to 22.20 mg/kg. Thus, both fresh and smoked mackerel tuna traded by eight fish sellers on the highway in Tuban regency were not safe for health. The results of this study are less in line with the research of Spanton and Saputra who reported that Pb was not detected in the Tuban Sea [17]. However, the results of this study are in line with the report of Umami *et al.* who reported that 4 samples of shrimp paste and 3 samples of salted fish obtained from Tuban have Pb levels that higher than limit [33]. The results of this present study and Umami *et al.* indicates that the Sea in Tuban has been polluted by Pb.

Metal is a natural component in the aquatic environment [3]. However, if the metal content and variation exceeds the threshold, the quality of the water decreases [4]. Similarly, an increase in Pb levels can reduce the quality of water and threaten the lives of various biota in the ecosystem [8, 37]. Increased levels of pollutant and decreased the quality of aquatic environment can come from several sources, both from natural sources [3, 6] or anthropogenic sources [3, 6, 38–40]. Various anthropogenic sources can increase Pb level in the ocean, such as from pesticides, electrical and batteries, alloys and solders, paints and pigments, fertilizer, refiners, plastic, as well as fuel [3]. Pb contamination due to human activity can occur directly or from Pb emissions released into the atmosphere [38]. Whereas in the Tuban area, contamination of seawater is indicated to come from shipping activities, fishing ports, fish auction sites, and industries in coastal areas that are suspected of using heavy metal materials [41]. The normal range of Pb concentration in seawater is <0.001–0.004 mg/L [42]. Based on the previous report, even though Pb was not detected at some point, there were at least six other points having concentrations above the normal range [41].

The presence of Pb in seawater can accumulate in the body of various aquatic biota [18, 20–22, 24–26]. In principle, the absorption of metal in aquatic organisms involves the transfer of the substance to the circulatory system [43]. Furthermore, various biota can be contaminated by Pb through their food chains [6, 37]. In this regard, Pb is included in a cumulative poison that accumulates more and more in the food chain starting from the primary producer [6]. In fish, there are four routes for Pb to enter the body, i.e., through drinking water, gills, skin, and food [37]. After entering the circulating system of aquatic organisms, Pb can accumulate in various tissues in various organs [6, 23, 25, 44].

The presence of Pb in the fish's body can cause health risks for humans who consume the fish [23, 28, 45]. Pb does not have biological functions in the human body, and its presence in the body can cause serious health effects [5]. As a result, the presence of Pb in the body can disrupt the respiratory system, circulation, coordination, digestion, and excretion [9]. Furthermore, the presence of large

amounts of Pb can cause acute poisoning which can affect hemoglobin synthesis, physiological function, reproductive effects, peripheral neuropathy, to impairment of neurobehavioral [6, 10, 11]. Pb is indicated to be able to influence the level of regulation of gene expression in the human body [46].

The presence of Pb in fish is also expected to increase in smoked fish. Correspondingly, Igwegbe *et al.* reported that smoked process in fish could significantly increase Pb levels [47]. The increasing of Pb level may due to smoke contains Pb. As a result, Pb attaches to fish meat. Based on Figure 1, smoked fish tend to have higher Pb levels than fresh fish. However, although there were differences in Pb levels, a Mann-Whitney test indicated that Pb level in smoked fish (Mdn = 19.05) was not significantly higher than fresh fish (Mdn = 12.13), $U = 50.00$, $p = 0.219$. However, the tendency of increasing Pb levels in smoked fish needs to be a concern as an effort to reduce the level of Pb contamination in fish bodies. Moreover, previous studies also reported that smoked process in fish could increase contamination of various heavy metals in the fish body [35].

Apart from seawater and smoking process, there is another source of contamination that might influence the results of this study. Based on Figure 1, the level of Pb in fish was different from one seller to the another. Based on the results, these differences may be due to differences in the location of the fish traders. The closer the seller's location with high-traffic vehicles, the more Pb pollutants that can stick to fish meat. As reported by several previous reports, vehicle pollution contains Pb [48, 49]. Reports have reported that various pollutants from vehicles can contaminate food sold on the roadside [50–52].

Fish smoking has become a popular method in preserving fish [53]. This method has been used by various communities in various countries [53, 54], including Indonesia [30, 55]. Fish smoking can also provide organoleptic characteristics in fish [56]. Unfortunately, despite the various benefits of smoking, there are some hazards that can arise from consuming smoked fish [56]. This study has indicated one of the dangers that arise from the process. Thus, consuming smoked fish must be with caution due to the health risk associated with the increasing of the heavy metal level.

4. Conclusion

The exposure of Pb on mackerel tuna showed the accumulation of these harmful metal compounds in the body of the fish. Based on the results of this study, all fish obtained from eight fish sellers in Tuban had Pb levels (0.33–22.20 mg/kg) that were higher than the maximum limit set by SNI No. 7387 the year 2009 (0.30 mg/kg). Although fish smoking was indicated to increase the Pb levels, the result from Mann-Whitney test informed that Pb level in smoked fish (Mdn = 19.05) was not significantly higher than fresh fish (Mdn = 12.13), $U = 50.00$, $p = 0.219$. Related to the results, control, and monitoring from the local government and central government to address pollution problems in Tuban waters also needs to be done. Besides, various activities of communities around the waters of Tuban need to be studied in correlation with Pb levels in these waters. These can be used as a first step to reduce the Pb level in the sea of Tuban.

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